

# Packwood Lake Hydroelectric Project

FERC No. 2244

Synthesis Report Meeting


June 27, 2007



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### Synthesis Report Meeting

- Description of the Synthesis Process
  - Review of Synthesis Statements by Geographic Area
    - Packwood Lake and tributaries
    - Lower Lake Creek
    - Tailrace
    - Cowlitz River/Tailrace Slough
    - Snyder and Hall Creeks
    - Roads and Trails
  - Report Conclusions
  - Wrap Up
- 

# Description of Process

- Synthesis Purpose
- Identify and evaluate the interrelationships among resources in and around the Project area and assess the Project's effects on them.

# Develop Alternative Hypotheses

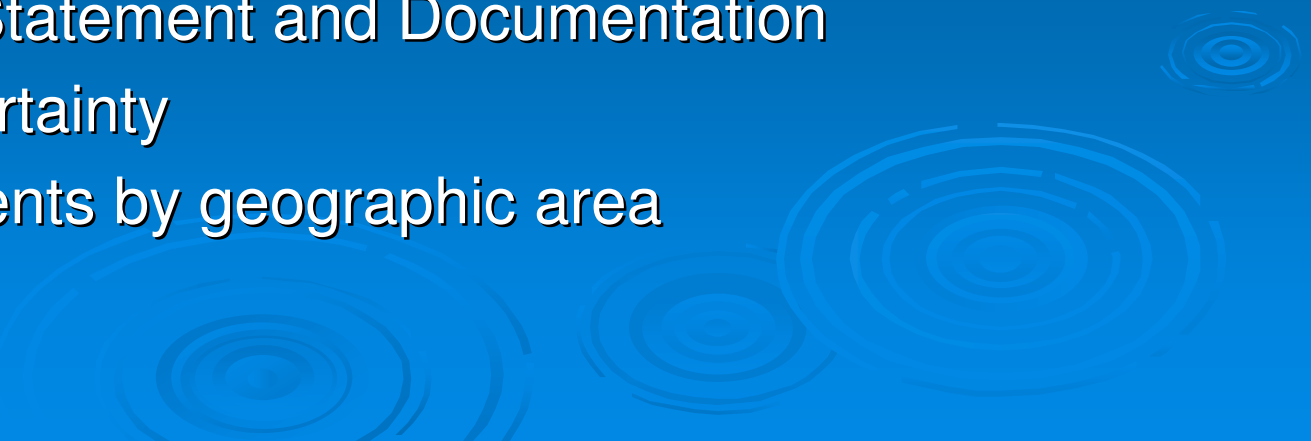
- Study plan nexus
- Key questions
- Study reports



# Critical Questions

1. What and where are the potential Project impacts altering watershed input variables?
2. What are the inputs delivered to the pertinent response areas (stream segment or other area of concern) and in what quantity?
3. What is the habitat or resource sensitivity to the inputs?
4. Is the Project impact a change from historical pre-project conditions due to the original construction of the Project, or is it an incremental additional effect that will occur during the new license term?
5. Are there non-project effects and, if yes, are they cumulative with Project effects
6. Is the effect routed to the resource?

# Elements of Analysis

- Develop hypotheses
  - Interdisciplinary team discusses and prepares synthesis statement
    - Inputs
    - Project Effects
    - Non-Project Effects
    - Affected Resources
    - Summary Statement and Documentation
    - Level of Certainty
  - Group statements by geographic area
- 

# Packwood Lake and Tributaries



# Drawdown Issue 1: Drawdown Effects on Rearing Trout in Packwood Lake

## Most Scientifically Viable Hypothesis

- Rainbow trout shift feeding locations from nearshore littoral habitats to deeper water pelagic sites as water temperatures increase, and remain there throughout the drawdown period. Thus, drawdown of the lake beginning in mid-September does not reduce functional habitat for rearing rainbow trout.
- There are 34 acres (7.6% total lake area) of littoral habitat between elevations 2857 ft MSL (summer lake elevation) and 2849 ft MSL (maximum drawdown level)

# Drawdown Issue 1: Drawdown Effects on Rearing Trout in Packwood Lake (continued)

- Adult and juvenile rainbow trout utilize littoral habitat for rearing in the spring and early summer. (107 fish were caught in littoral habitat in May 2006.)
- Trout move deeper as summer water temperature increases
- Drawdowns between mid-July through April have minimal effect on trout rearing
- Level of certainty: moderate

# Drawdown Issue 2: Drawdown Effects on Aquatic Vegetation in Packwood Lake

## Most Scientifically Viable Hypothesis

- The relatively sparse distribution of aquatic plants in Packwood Lake between elevation 2857 ft MSL and approximately 2852 ft MSL is partially a result of plant desiccation during winter drawdown of Packwood Lake by Project operations. The isolated location of Packwood Lake and lack of boat access minimizes the potential for introduction of non-native aquatic plants.
- *Elodea canadensis* (a native species) is only species observed

## Drawdown Issue 2: Drawdown Effects on Aquatic Vegetation in Packwood Lake (continued)

- Patchy distribution with distinctive band at about 2852 ft MSL
- Winter drawdowns freeze out plants
- Cover is not a key concern for trout in the lake
- Level of certainty: High



## Drawdown Issue 3: Cultural Resources around Packwood Lake

- Archaeological site 45LE285 is located on and adjacent to the Packwood Lake shoreline
- Erosion is affecting site:
  - Wave erosion in drawdown zone (Project affect)
  - Wave erosion on shoreline (natural lake – non Project effect)
  - Recreational use is causing erosion (trampling, climbing on banks – non-Project effect)
- Causes inter-related, both Project and non-Project effects

# Drawdown Issue 4 – Effects on Amphibians Associated with Wetlands Adjacent to Packwood Lake

## **Most Scientifically Viable Hypothesis**

- Project-induced lake level fluctuation has a limited effect on amphibians breeding in Packwood Lake lacustrine fringe wetlands.

## Supporting Facts:

- Three species of amphibians (northwestern salamander, Pacific treefrog, and Cascades frog) breed within a few relatively shallow depressions on the southeastern edge of Packwood Lake.

## Drawdown Issue 4 – Effects on Amphibians Associated with Wetlands Adjacent to Packwood Lake (continued)

- Packwood Lake surface elevation is held relatively constant from May to mid-September. Breeding likely occurs in May most years. Cascades frog and Pacific treefrog larvae grow and develop during this period, and should complete metamorphosis before mid-September.
- Northwestern salamander larvae develop more slowly and rarely metamorphose in their first year – larval stranding during seasonal drawdown is probable.
- Northwestern salamanders are found at the Project – therefore, a sustainable population must exist there or nearby.

# Drawdown Issue 5 – Effects on Wetland Vegetation

## Most Scientifically Viable Hypothesis

- The hydrology for wetlands adjacent to Packwood Lake exhibits complex patterns that vary spatially and seasonally. Upslope hydrology that is a function of precipitation and runoff dominates wetland hydrology for all wetlands during winter and spring (November – June).
- During drier periods (July – October), lake level has a greater effect on wetland soil saturation for some, but not all, of the adjacent wetlands. The relative influence of lake level varies spatially dependent upon soil conditions, topography and drainage patterns. Since vegetation is beginning to go seasonally dormant at the time of the fall drawdown, the effects on wetland vegetation are minimal.

# Drawdown Issue 5 – Effects on Wetland Vegetation (continued)

- Variable response seasonally and spatially: wetland portion closest to lake at upper end of lake most affected in summer.
- May have the effect of maintaining a slightly higher groundwater table within the nearshore portion of the wetland complex at the head of Packwood Lake during late summer.
- Non-native vegetation within wetland a function of recreation

# Fish Distribution and Species Composition

## Issue 1 – Effects on Migration of Spawning Rainbow Trout

### **Most Scientifically Viable Hypothesis**

- Rainbow trout spawning migration does not coincide with periods of lake drawdown. Potential project related blockages are not an issue during this time of year (May 15 – July 15).

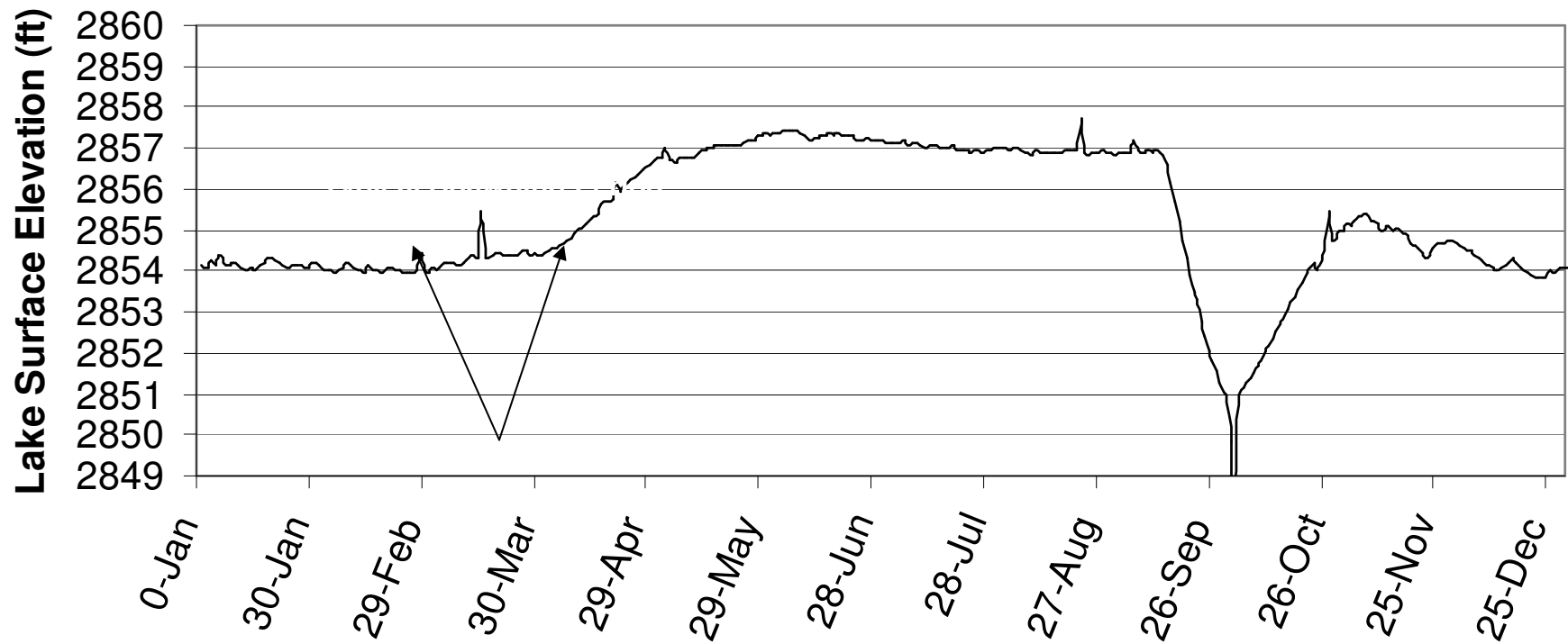


# Fish Distribution and Species Composition

## Issue 1 – Effects on Migration of Spawning Rainbow Trout (continued)

- An adfluvial population of rainbow trout resides in Packwood Lake and utilizes its primary tributaries for spawning and rearing purposes. A typical year would see rainbow trout migrating from Packwood Lake in May and June to spawn in Crawford, Beaver Bill, Upper Lake, Muller, Trap and Osprey Creeks. The spawners typically return to the lake immediately after spawning occurs, leaving the tributaries by early July at the latest (Energy Northwest Fish Distribution and Species Composition Report, in preparation, July 2007). The rainbow trout spawning migration coincides with spring runoff when stream flows and the corresponding lake level are typically at the highest stage of the year.

## Average Daily Packwood Lake Elevation (1971-2006)



# Fish Species Distribution and Composition Issue 2

## – Effects on Migration of Juvenile Rainbow Trout

### **Most Scientifically Viable Hypothesis**

- Juvenile rainbow trout migration from tributaries into Packwood Lake does not coincide with periods of drawdown, so there is no Project effect.



## Fish Species Distribution and Composition Issue 2 – Effects on Migration of Juvenile Rainbow Trout

- Juvenile rainbow trout migrate from their native streams prior to the drawdown of Packwood Lake. Low water in the tributaries in August and September typically cues out migration behavior. A low water survey was conducted on August 8, 2006 during which over 1000 juvenile rainbow trout were seen in Crawford Creek. Prior to Crawford Creek going completely dry, as it naturally does, in late August or early September, a supplemental survey was done. Very few juvenile rainbow trout remained in Crawford Creek. The fish had out-migrated to Packwood Lake. It is important to note that the occasional dewatering of the tributaries is a natural occurrence and would occur sporadically without the existence of the Project.

# Lower Lake Creek



# Fish Population Characterization near the Drop Structure Issue 1

## Most Scientifically Viable Hypothesis

- Some of the resident population of rainbow trout in Packwood Lake is infrequently routed to lower Lake Creek as a result of overtopping of the drop structure. Given the healthy rainbow trout population in Packwood Lake, the relocation of a small number of fish will not impact Packwood Lake populations but may benefit lower Lake Creek by supplementing existing populations.
- As spawning surveys from the lake tributaries demonstrate, the adfluvial population of rainbow trout that utilize Packwood Lake is at a very healthy level. Currently the 2007 spawning surveys are taking place in tributaries to Packwood Lake and are showing high numbers of spawners in their characteristic tributaries relative to historical documentation.

# Fish Population Characterization near the Drop Structure Issue 1 (continued)

- During one overnight gill netting effort in Packwood Lake in early May 2006, 105 rainbow trout were captured.
- Conversely, during an electroshocking effort in August 2006 that spanned the entire 1464 ft reach below the drop structure, a total of only 12 rainbow trout were captured. The average size of rainbow trout captured in the lake was 242 mm versus 124 mm in the isolated reach of lower Lake Creek below the drop structure



# Fish Population Characterization near the Drop Structure Issue 1 (continued)

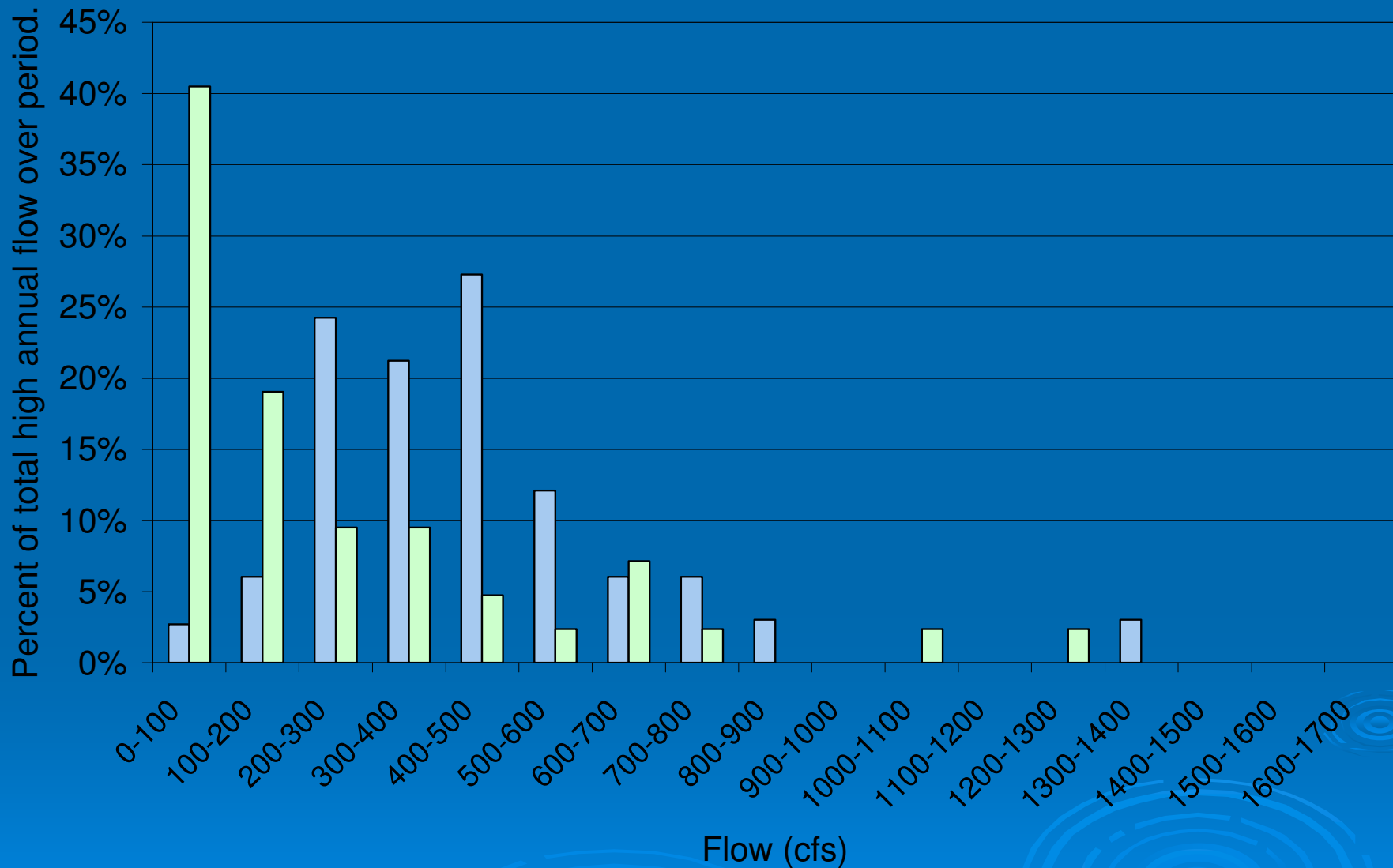
- The highest number of fish ever observed in the isolated reach of lower Lake Creek occurred in late May 2006 when 30 to 40 rainbow trout were observed immediately below the drop structure. These fish were oriented directly into the release flow coming from the lake and were larger by approximately 50 mm than the other fish observed in the reach on subsequent surveys. It is very likely that these fish were routed over the drop structure during overtopping events occurring in conjunction with gravel studies in lower Lake Creek.

# Fish Population Characterization near the Drop Structure Issue 1 (continued)

- Spawner surveys are ongoing in the isolated reach and will be described in detail the Fish Distribution and Species Composition Report. To date, no spawners or redds have been observed in the isolated stretch of lower Lake Creek.
- The occasional introduction of a limited number of rainbow trout from Packwood Lake could potentially assist in increasing the population numbers and overall health of the naturally isolated populations in lower Lake Creek.

# Instream Flow Issue 1: Peak Flow Effects on Gravel and Large Wood in Lake Creek

- Changes to gravel and large wood in Lake Creek downstream of drop structure can affect fish habitat
- Project effects:
  - Project operations reduce magnitude and frequency of peak flows in lower Lake Creek
  - Large wood does not move from Packwood Lake to lower Lake Creek
- Non-project effects:
  - Packwood Lake (natural) traps gravel; limited sources downstream of drop structure
  - Size/configuration of Lake Creek limits transport of large woody debris
  - Past timber harvest in riparian areas (RM 0-0.8)
  - Residential development/bridges constrict stream (RM 0-0.3)

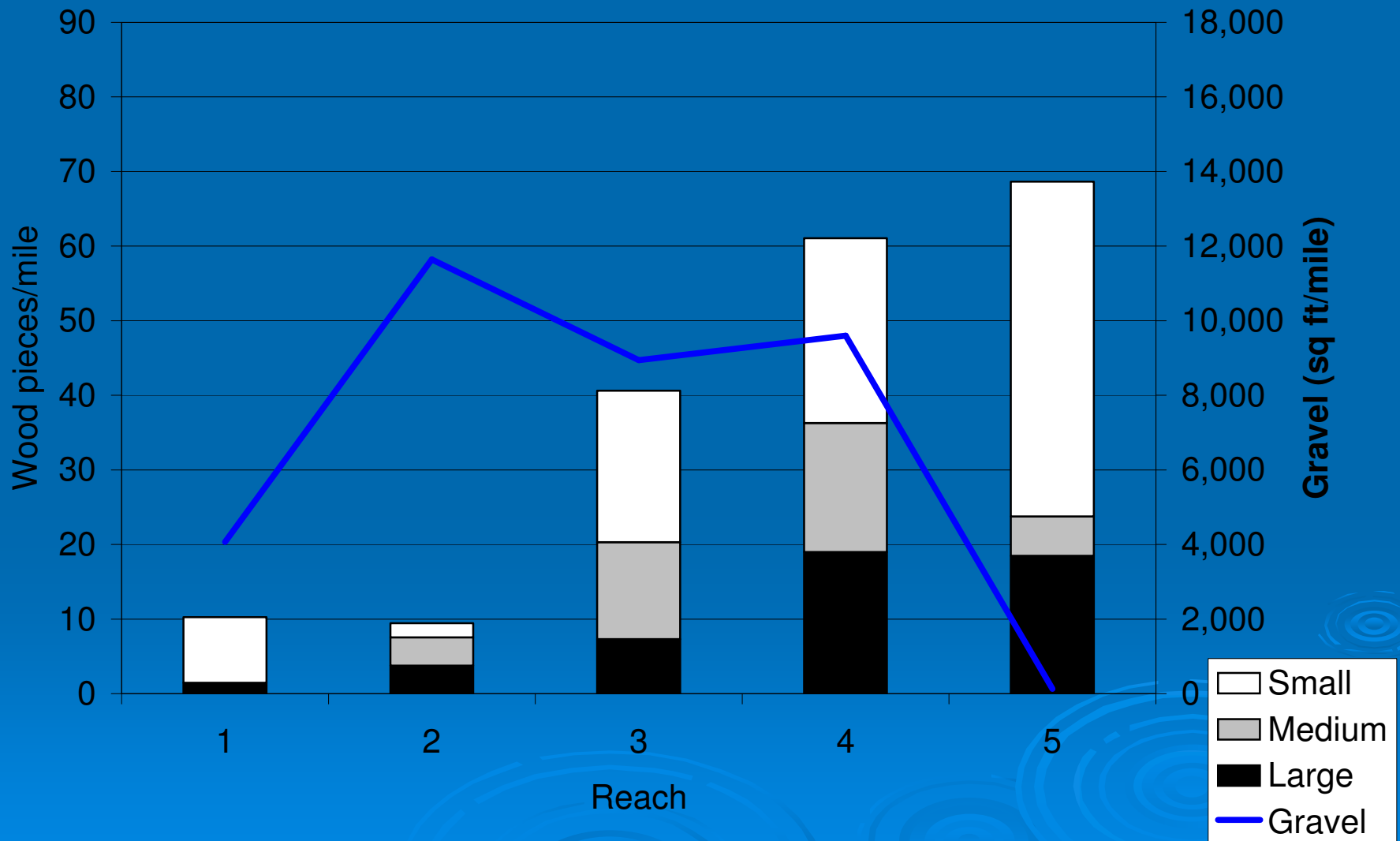


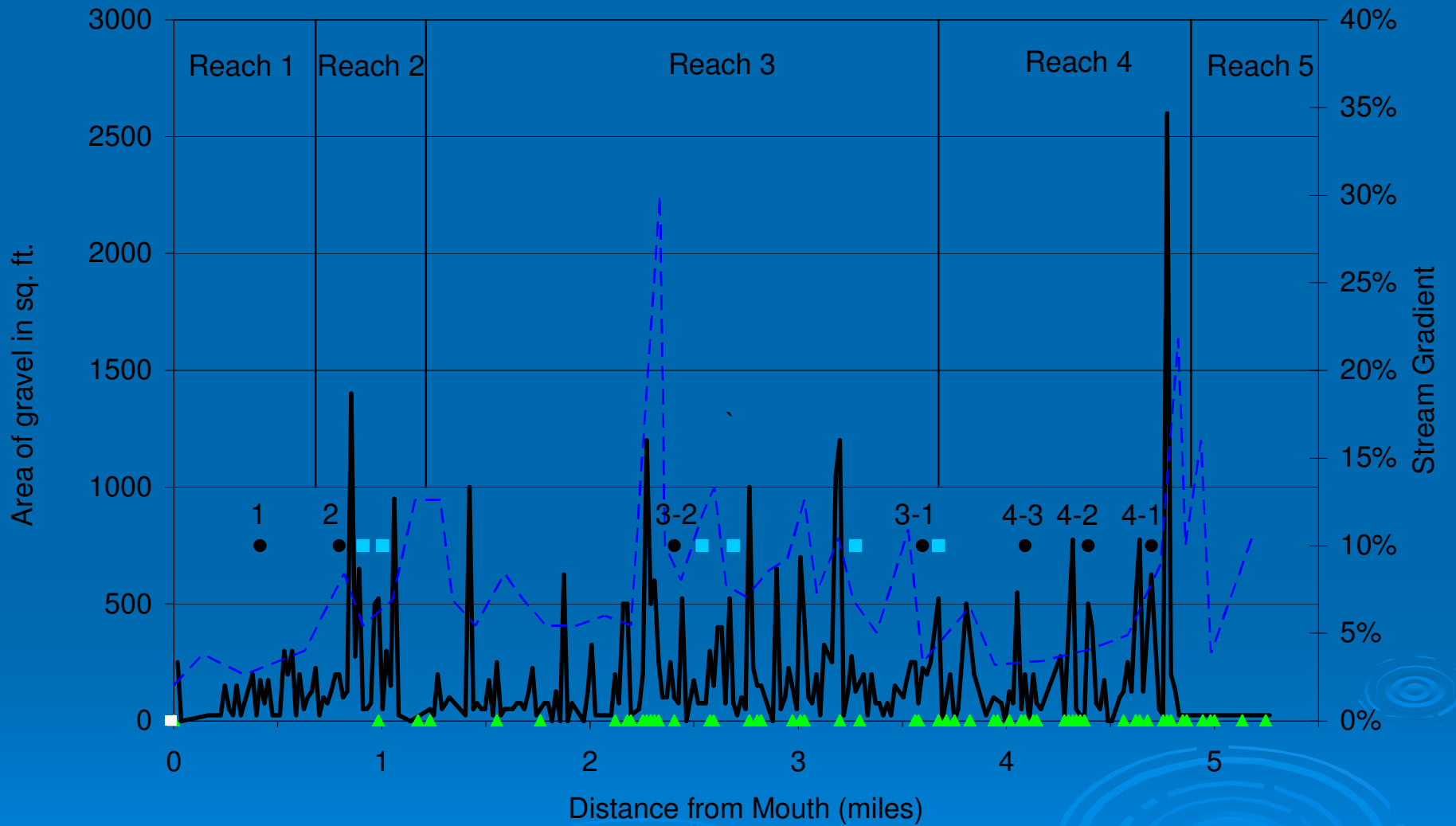
1912-1963\*
  1965-2006\*\*

\* 1912-1963 includes 1912-1917, 1919-1924, 1931-1942, 1950-1954, 1960-1963

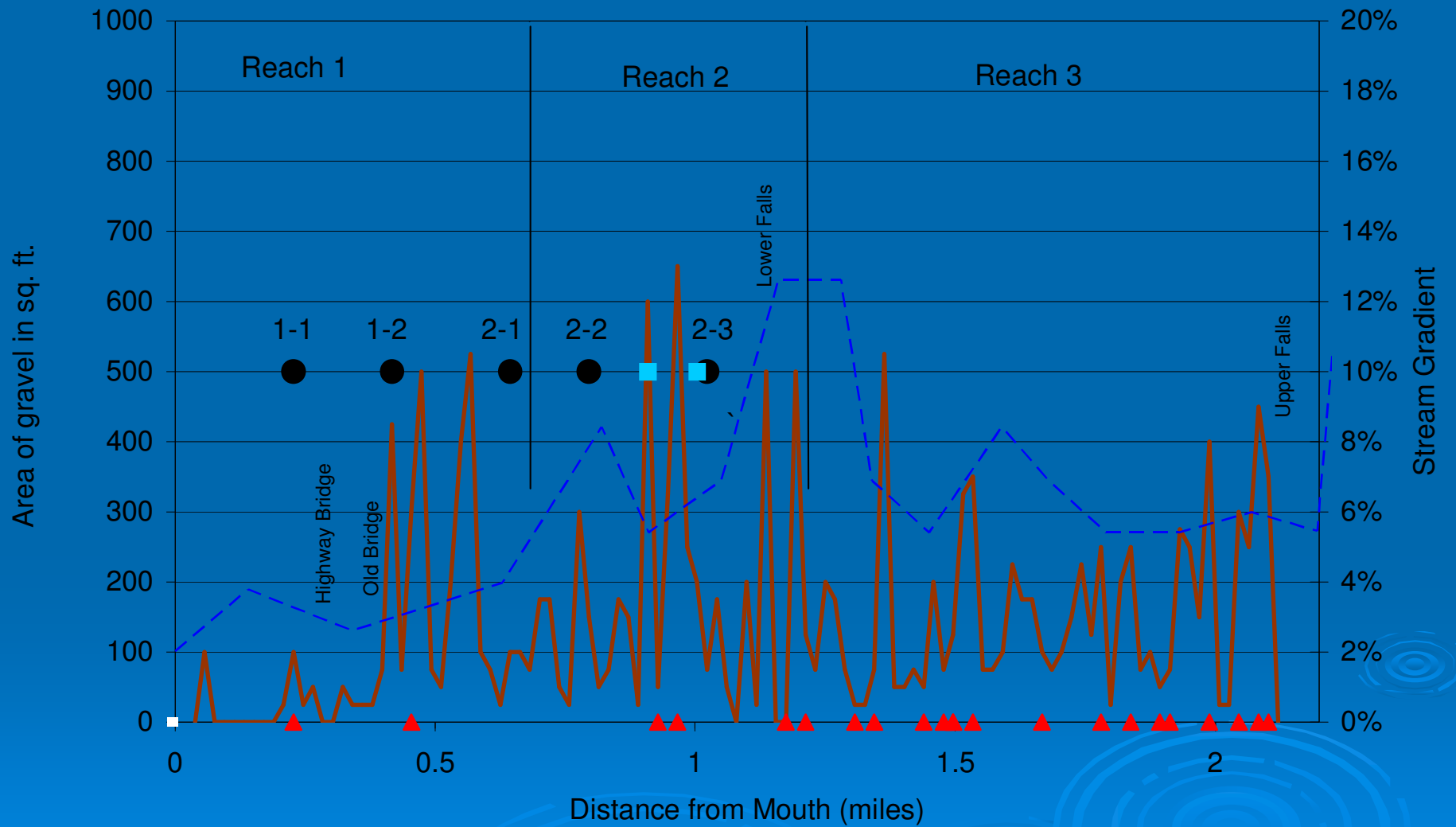
\*\* 1965-2006 does not include the 299 cfs spill performed as part of licensing studies

# Large Wood and Gravel per Mile in Wetted Channel





— Gravel      ▲ Log Jams      - - - Gradient      ● Gravel Study Sites      ■ Tributaries



— 2007 Gravel    
 - - - Gradient    
 ▲ 2007 Log Jams    
 ● Gravel Study Sites    
 ■ Tributaries

# Gravel/Large Wood

- Painted rock study
  - 250-300+ cfs needed to move 3-4" gravel
  - Also moves rocks in Reach 1 and 2
- Lack of wood/gravel retention downstream of RM 0.8
- Combined Project and non-Project effects
  - Few sediment sources
  - Reduced transport
  - Lack of gravel retention structures
- Spawning habitat RM 0-1.03 limited and fully seeded

# Instream Flows Issue 2 – Adequacy of Flows for Stream-dwelling Fish

## Most Scientifically Viable Hypotheses

- The reduction in flows has reduced the wetted area and altered depths and velocities of habitats available to resident and anadromous fish, benthic macroinvertebrates, and stream-dwelling amphibians. Different reaches possess different physical characteristics, which favor some species and life stages over others. Decreased flows in lower Lake Creek alter the physical habitat available for amphibians and both resident and anadromous fish.

# Instream Flows Issue 2 – Adequacy of Flows for Stream-dwelling Fish (continued)

## Supporting Facts:

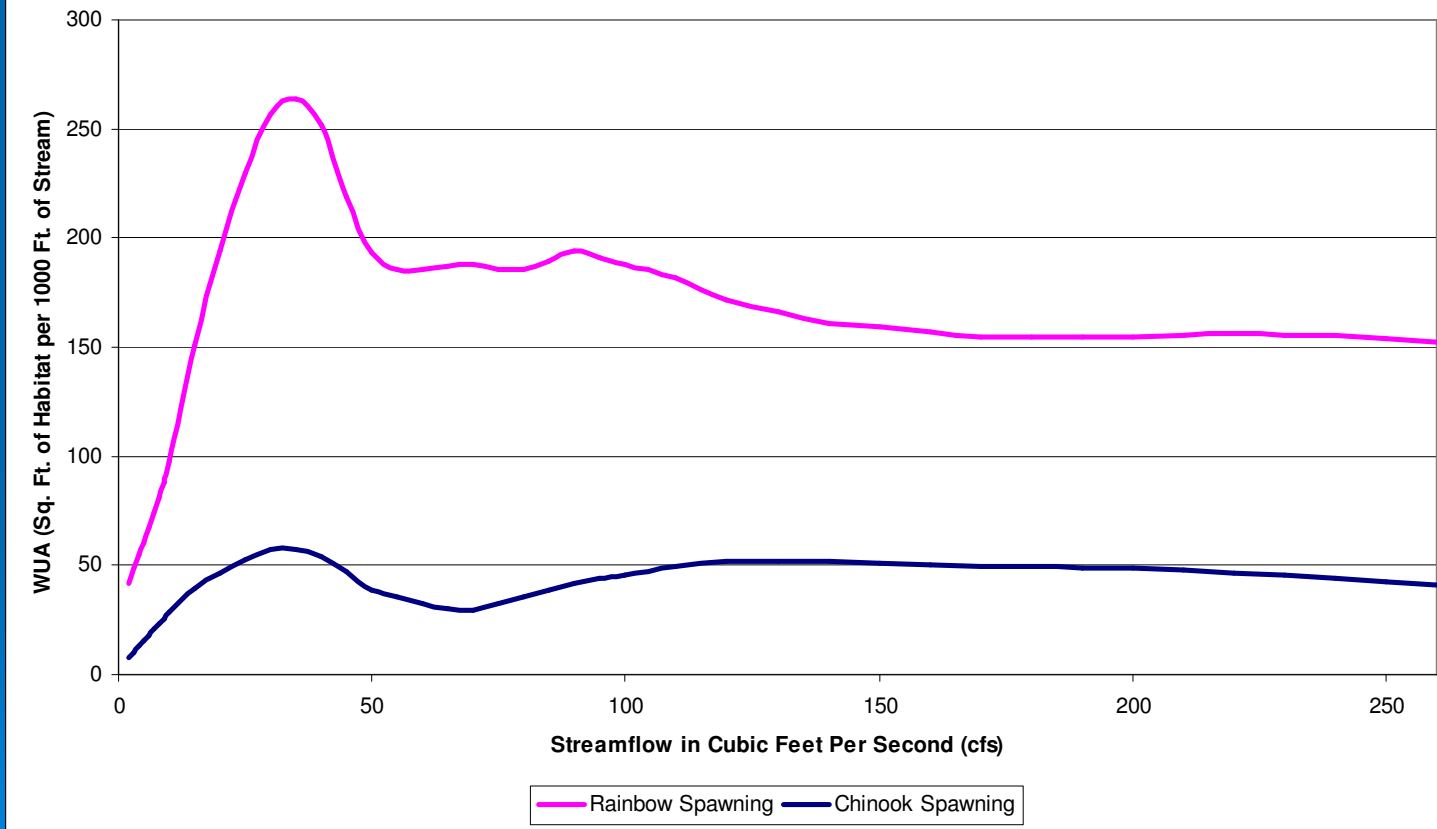
- Through the studies conducted and agency consultation, it was determined that Chinook and coho salmon and sea-run cutthroat trout could migrate up Lake Creek as far as RM 1.03, where a chute/falls complex blocks access. Steelhead trout adults could migrate as far as RM 1.95 where a 25 ft falls complex prevents their continuing upstream (EES Consulting 2006d). Resident rainbow trout are found throughout lower Lake Creek. Anadromous fish are represented by IFIM study sites 1 and 2, while resident rainbow trout were modeled at all 4 study sites. Adequacy of flows for fish and amphibians, is addressed in Section 4.2.5 of the Synthesis Report.

## Instream Flows Issue 2 – Adequacy of Flows for Stream-dwelling Fish (continued)

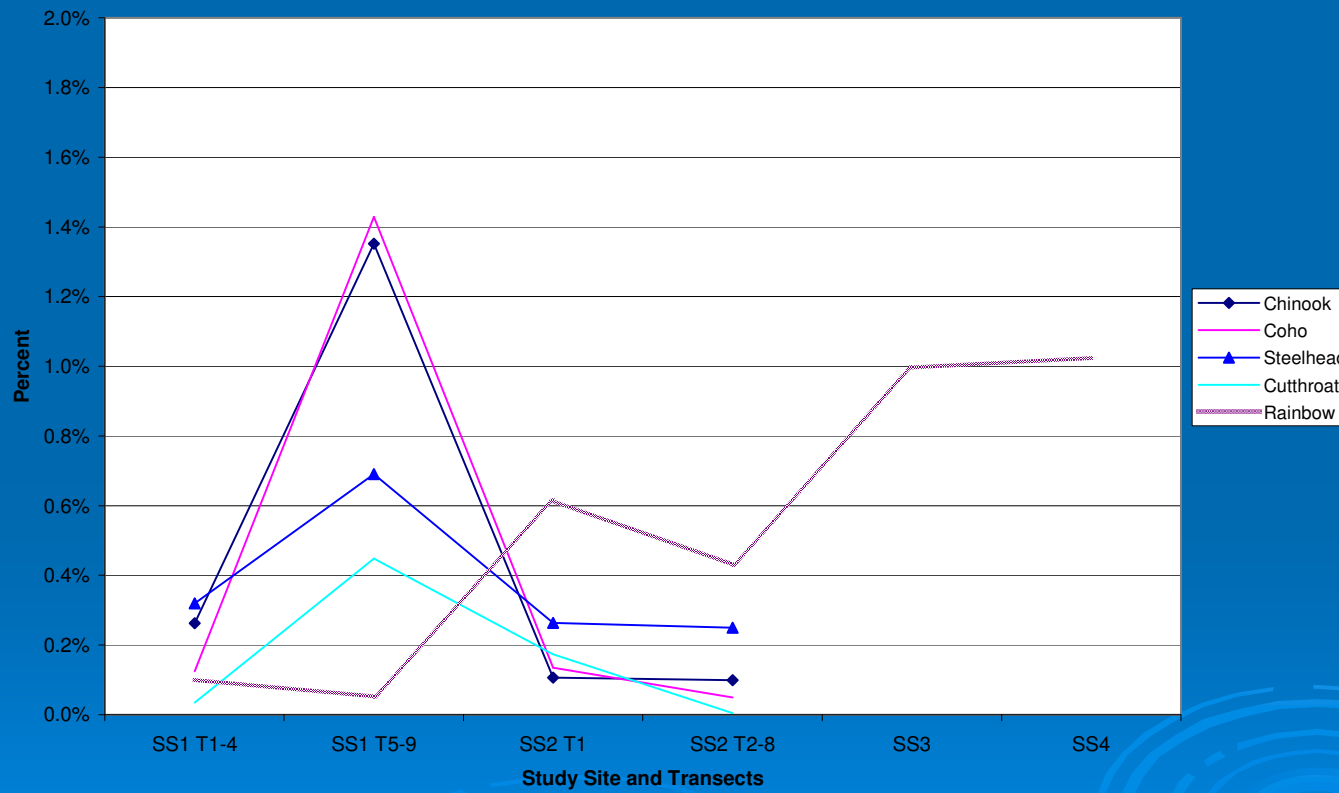
- Fish Spawning Habitat: Spawning habitat for both anadromous and resident fish in Lake Creek is scarce; it is defined as the area (in square feet) where the combination of suitable spawning-sized substrates, and water depths and velocities that anadromous and resident fish prefer for spawning and depositing eggs in redds is present.



Lake Creek IFIM July: Fish Spawning Habitat (WUA) vs. Flow

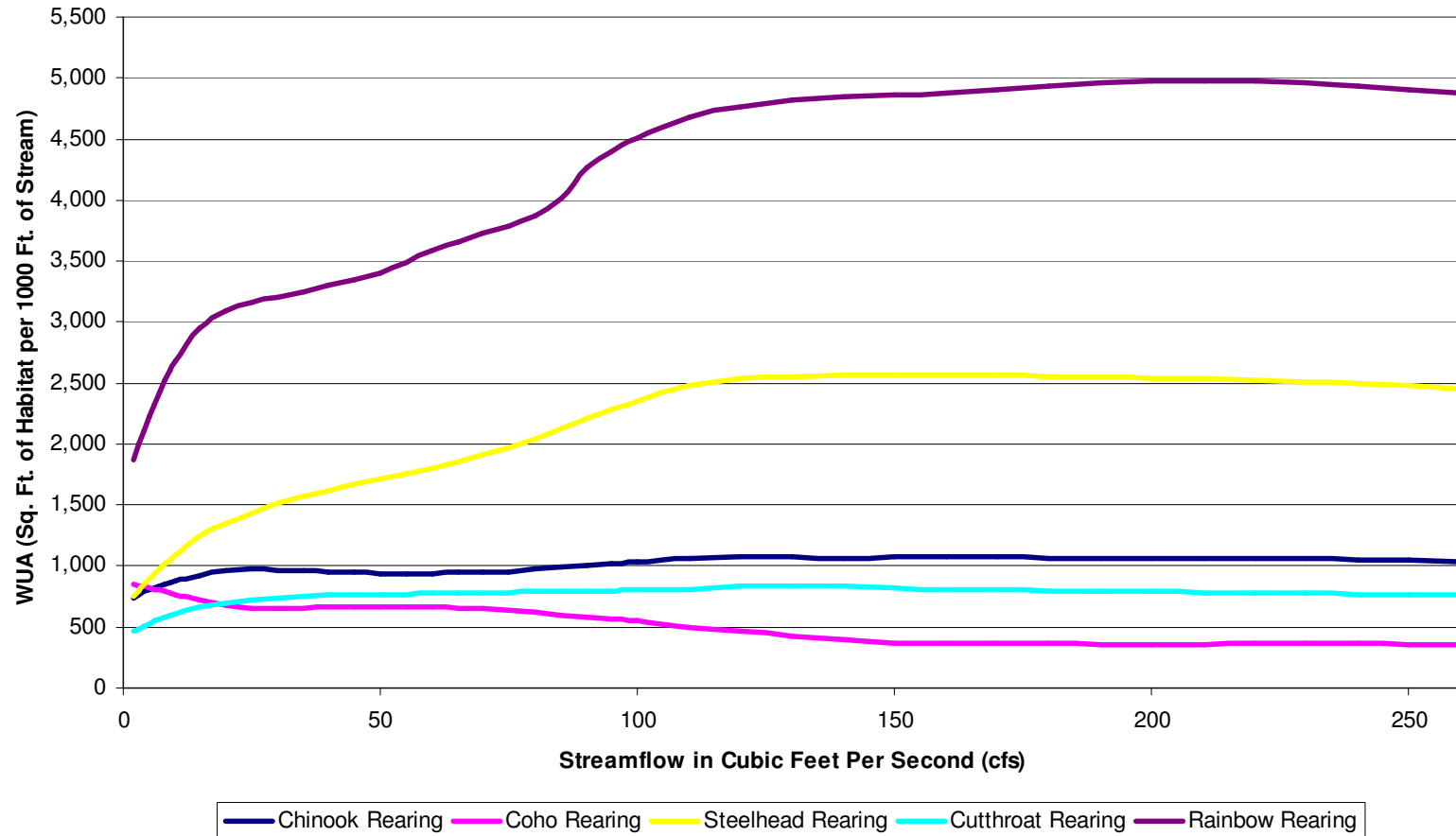


Spawning WUA as % of Total Habitat Available

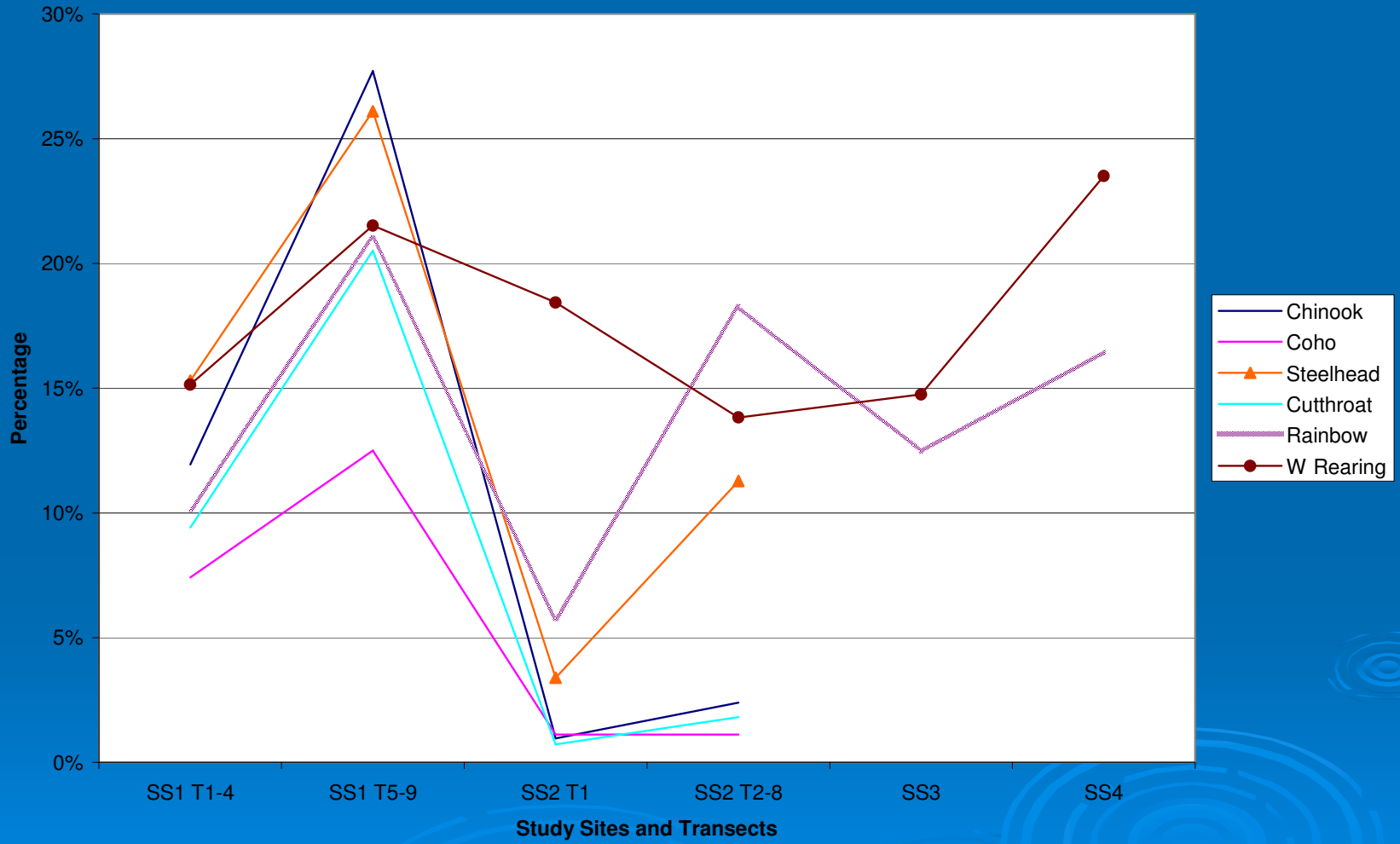


- Salmon and Trout Rearing Habitat: Figure 14 (from Figure 5.2-13 of the Lake Creek Instream Flow report) shows rearing habitat for salmon and steelhead in Lake Creek during July. Different species and life stages prefer various depths and velocities; as a result, maximum WUA rarely coincides at the same flow for all species.

Figure 5.2-13 Lake Creek IFIM July: Fish Rearing Habitat (WUA) vs. Flow



### Rearing WUA as % of Total Habitat



# Water Quality Issue 1: Water Temperature in Lake Creek

## Most Scientifically Viable Hypothesis

- Reduced stream flows in lower Lake Creek result in summer water temperatures within lower Lake Creek that are lower than would occur naturally without the Project due to the high proportion of groundwater. As a result, the longitudinal extent of warm water-tolerant macroinvertebrate taxa is shortened. The resulting cooler water temperatures are preferential for fish species (resident and anadromous) pertinent to lower Lake Creek.
- Downstream water temperature is a function of groundwater accretion

# Water Quality Issue 1: Water Temperature in Lake Creek (continued)

- Existing 3cfs below drop structure: natural pre-Project August = 77 cfs
- Modeled existing with and without Project, 7Q2 (56.4 cfs) and 7Q10 (39.9 cfs) August low flow
- Without Project, warm water flowing out of lake (19-20°C) cools about 1-2°C
- Cooler temperatures a benefit to fish, reduced extent of tolerant benthic taxa and greater taxa richness

# Flow Effects on Lake Creek Amphibians

## **Most Scientifically Viable Hypothesis**

- Instream amphibians are supported by current Project operational conditions: minimum flows are sufficient and periodic high flow events move silt and other fine sediments that might otherwise clog the interstices of coarse substrates and smother food organisms. Streamside-specialist amphibians probably do not occur along lower Lake Creek; however, if these species are present, the suitability of their preferred splash zone habitats is not governed by flow characteristics because other requisite habitat features are lacking.

# Flow Effects on Lake Creek Amphibians (continued)

## Supporting Facts:

- Two stream-associated species of amphibians were widely documented in lower Lake Creek: coastal giant salamander and coastal tailed frog.
- Coarse substrates are predominant in Lake Creek. Sand-embedded substrates occurred at some sites, but mostly in low gradient sections or downstream of sediment sources. Silt-covered substrates were not evident.

# Flow Effects on Lake Creek Amphibians (continued)

- Periodic, natural high flow events occur resulting from precipitation and snowmelt. Extreme flow events may reduce larval amphibian populations. However, the magnitude and rate of stage increase during high flow events are overwhelmingly beyond the control of the Project.
- Streamside specialist amphibians were not found along lower Lake Creek. Potential habitats are concentrated in areas which are either lacking in rocky cover or are within tributaries or seeps not affected by the Project.

# Tailrace



# Fish Use of Lined Tailrace and Stilling Basin

## Most Scientifically Viable Hypothesis

- During summer months when the Project temporarily shuts down and during fall Project shutdown, biological oxygen demand depletes dissolved oxygen levels in the stilling basin. This can stress anadromous fish rearing in the stilling basin and adversely affect survival of incubating spring Chinook eggs.
- When the Project is operating dissolved oxygen (DO)  $\leq$  0.5 mg/L diurnal variation
- DO diurnal variation in stilling basin when Project shutdown about 1 mg/L
- Fish rescue and installation of permanent barrier eliminates impact.

# Cowlitz River/Tailrace Slough



# Tailrace Slough Use by Anadromous Salmonids

## Most Scientifically Viable Hypothesis

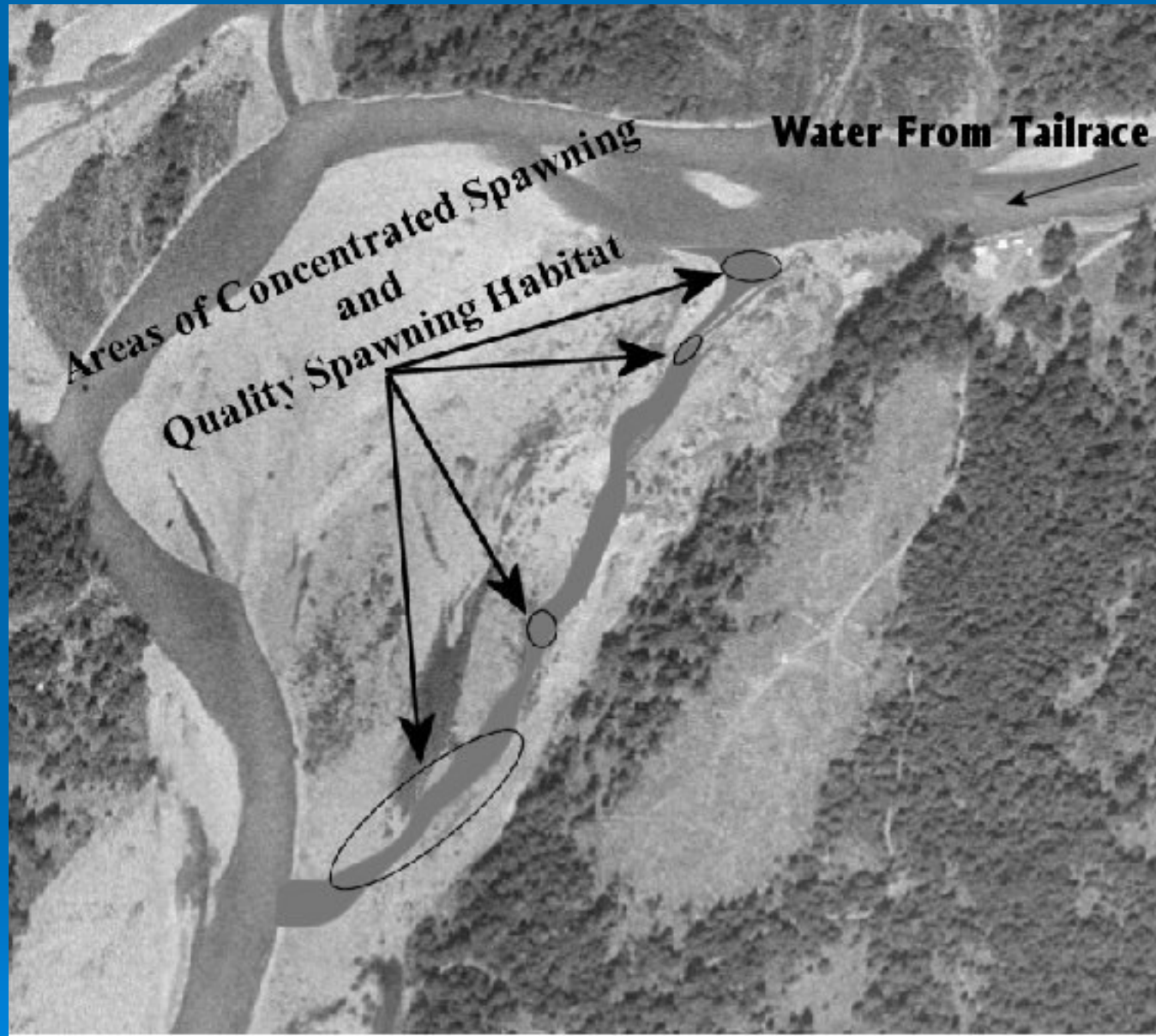
- In years when the tailrace slough has been configured in such a way as to be dependent upon Project operations, reduction or cessation in Project flows can impact the following:
  - 1) the availability of spawning habitats for federally listed species (anadromous stocks) found in the Project area;
  - 2) eggs deposited in the gravel may be subject to dewatering or desiccation; or
  - 3) anadromous fish present in the tailrace slough (fry, juvenile, or adult) may be subject to stranding.

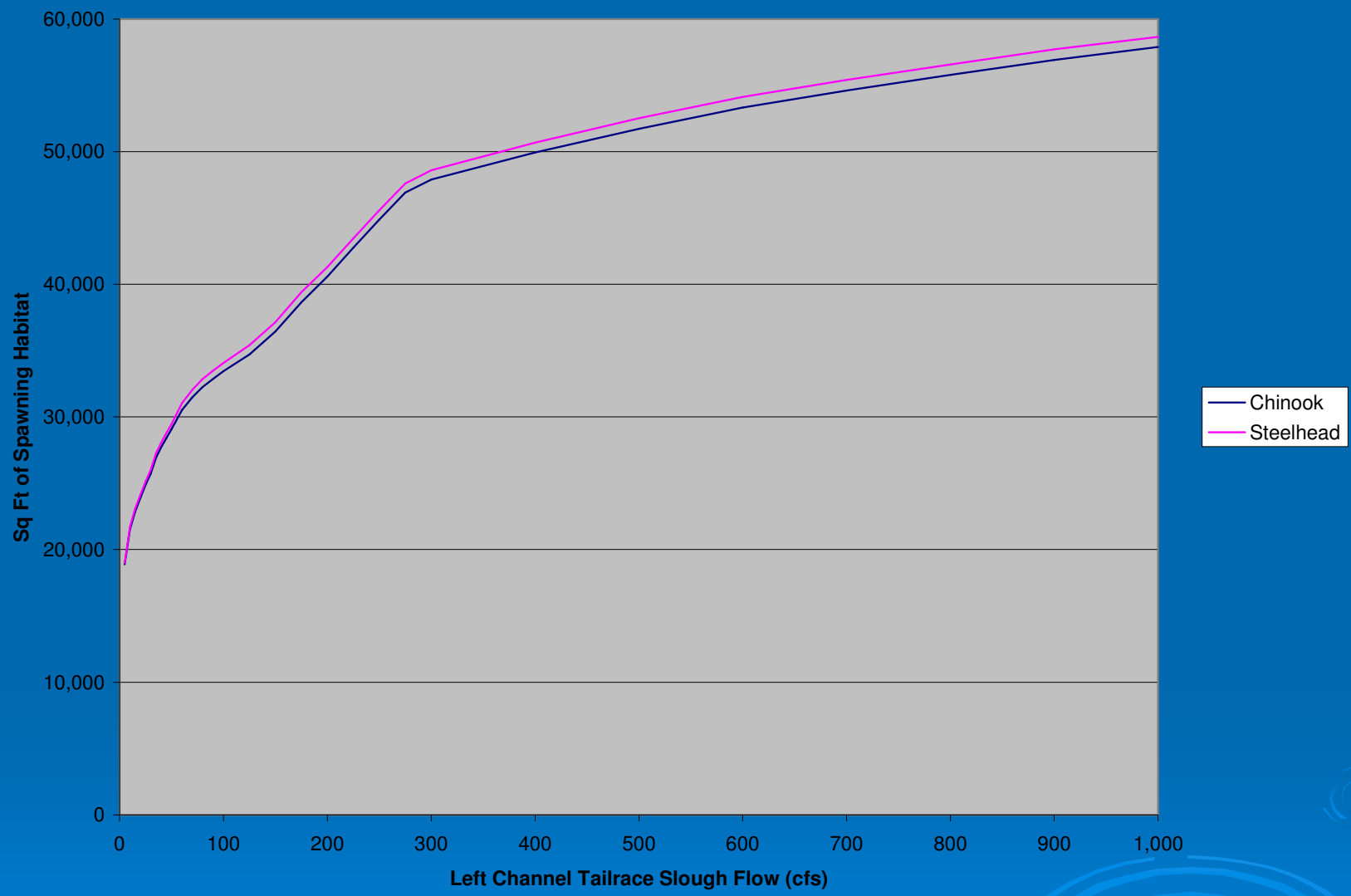
# Summary Statement and Documentation

- Water in the tailrace slough is a function of water from the Cowlitz River and tailrace flows. The contribution from the Cowlitz River side channel is highly variable due to the dynamic nature of the river. The contribution from the Project is also variable, based upon Packwood Lake levels and subsequent generation; the Project is also subject to shutdowns.
- Depending upon high flow activity in the upper Cowlitz River, the tailrace slough flow may either be largely dependent upon the Cowlitz River, Project operations, or both.
- The potential reduction in habitat through reduced flows during spawning and rearing timing may result in a reduced production potential for resident and anadromous fish.

### Packwood Tailrace Slough Spawning Data and Associated Water Temperature Information (2004)

Date	Fish Observed	Redds Observed	Mean Daily Water Temperature (°C)
11/11/04	3	3	7.73
11/23/04	14	9	7.00
12/9/04	14	45	5.38
12/21/04	2	0	4.63





# Conclusions

- low conditions in the tailrace slough can change every year. Since 2004, the tailrace slough configuration has changed 4 times: in the fall 2004; in the fall 2005; in the fall 2006, and in the spring 2007.
- In 2004, 2006 and 2007, Cowlitz River flows configured the tailrace slough as to make it highly dependent upon the Project in low-flow conditions. In 2005, however, a much larger percentage of the Cowlitz River was diverted into the tailrace slough, and it was not dependent upon the Project at all in the fall.

# Conclusions (cont'd)

- Whether and how, Project flows may be of benefit to the fish in the tailrace slough depends upon the following:
- The configuration of the Tailrace Slough by the Cowlitz River; in some years, a large enough percentage of the Cowlitz River courses through the Tailrace Slough so that Project flows are not required;
- Project flows, which are dependent upon
  - Instream flow requirement for Lake Creek below the Drop structure;
  - Inflows to Packwood Lake, which affect Packwood Lake elevations and storage requirements
- Flexibility of the Project to adjust the timing of the scheduled maintenance outage

# Water Quality Issue 2: Project Effects at the Tailrace Terminus

## Most Scientifically Viable Hypothesis

- The majority of the outflow from Packwood Lake during summer months is used for power production (a minimum of 3 cfs is released to Lake Creek below the drop structure). The temperature of flow from the lake that is routed through the tailrace remains relatively constant between the lake and the tailrace outlet. A slight cooling would occur if this water were routed down Lake Creek to the Cowlitz River. The net effect on water temperature of the Cowlitz River from the combined flow from Lake Creek and the tailrace during summer months is negligible.
- Modeled Lake Creek temperature with and without the Project

## Water Quality Issue 2: Project Effects at the Tailrace Terminus (continued)

- Simple mass balance analysis of combined Lake Creek and tailrace flow effect on Cowlitz River temperature
- No significant increase in water temperature for fully mixed flow.



# Effects on Rare Plants

## **Most Scientifically Viable Hypothesis**

- Storm events that create high flows in Lake Creek and the tailrace are not of significant magnitude to negatively impact erosion that would impact Oregon goldenaster populations on the Cowlitz River via Lake Creek, relative to peak flows of the Cowlitz River.



# Effects on Rare Plants (continued)

## Supporting Facts

- The Study area was surveyed for rare plants in 2005 and 2006. Project related high flows and storm events that create high flows in Lake Creek and the tailrace are not of a significant magnitude to negatively impact Oregon goldenaster subpopulations in the Study area. Both subpopulations of Oregon goldenaster are located upstream of, or are elevationally higher than Project-related high flows at either the tailrace or Lake Creek. Seasonal river flooding is probably important in maintaining the habitat for this species (WNHP 2007). Population dynamics of Oregon goldenaster subpopulations are inter-dependent on the hydraulics of the Cowlitz River with which they are associated.

# Snyder and Hall Creeks



# Fish Distribution and Species Composition 3

## **Most Scientifically Viable Hypothesis**

- The Snyder Creek culvert can become blocked with large amounts of sediment that have eroded and settled out in the culvert, at the culvert outlet or near the drain. The blockage of the culvert can prevent spawning coho and cutthroat from accessing documented spawning and rearing habitat that extends up about 1900 feet from the tailrace crossing. If the culvert becomes blocked prior to downstream migration, juvenile coho and cutthroat can become stranded in Snyder Creek.

- Energy Northwest cleaned out the upstream drain in April 2007, allowing downstream passage of fish to lower Snyder Creek, Hall Creek, and potentially the Cowlitz River. The remainder of the culvert will be cleaned out during the low flow period in 2007.
- Level A analysis indicated that a Level B analysis was required for Snyder Creek at the tailrace, because the culvert width (4 ft) is less than 75% of the average streambed toe width at the second riffle downstream of the culvert. Level B analysis indicated that the calculated depths and velocities at the upstream end of the culvert meet the Criteria for trout in WAC 220-110-070. Therefore, the culvert is deemed passable. Table 10 below summarizes the data from the Level B and

# Snyder Creek Crossing – WDFW Stream Simulation Model

- WDFW Stream Simulation Model indicates that the culvert does not pass the no slope model; a Priority Habitat Index was generated for the habitat upstream
- PHI was conducted for coho salmon and cutthroat trout.
- PHI was
  - 2.74 for coho salmon
  - 1.83 for cutthroat trout
  - 4.57 total

# Roads and Trails



# Noxious Weeds Issue 1

- Ground disturbance and noxious weed introduction and spread in the Project area are caused by a variety of inputs that are both Project related and non-project related.
- Project related and non-project related maintenance of right-of-ways, roads, penstock, pipeline, tailrace, trails, and power lines create disturbed habitat in the Project area where weeds have a competitive advantage over native plant species.
- Once noxious weeds are established in an area, they are often self-sustaining regardless of whether the disturbance continues.
- Continued operation of the Project may provide avenues for noxious weed introduction, establishment and spread.
- Other uses of the Project area, including recreation may also provide avenues for noxious weed introduction, establishment and spread.

## Noxious Weeds (continued)

- The Study area was surveyed for noxious weeds in 2005 and 2006.
- Noxious weeds present in the Project area include: meadow knapweed, Japanese knotweed, butterfly bush, diffuse knapweed, Canada thistle, and reed canary grass. These weeds are associated with various types of disturbance, whether or not they are a direct result of Project related activities. It is not known how long these populations have been present in the Project area. Energy Northwest has a noxious weed control plan which establishes responsibilities and requirements for the control of noxious weed infestations, and which addresses noxious weed species currently present in the Project area (Energy Northwest 2007). These control efforts will be done in conjunction with the USDA Forest Service and the Lewis County Noxious Weed Control Board.

# Roads and Trails Issue 1

- Use and maintenance of roads and trails increase sediment input to hydrologically connected streams
- Project and non-Project use
- Estimated input low (7 tons/yr from ~14 miles of Project-related roads/trails)
- No effects measured on water quality or aquatic resources



# Report Conclusions

